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The Development of Pearl Aquaculture in the Americas: Results of a Sea Grant Gulf of Mexico Regional Workshop: Foreword

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DEDICATED SECTION

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Foreword

Pearls have a mystique as status symbols, gems for family heirlooms, even for their healing powers as medicinals. For centuries, natural pearls were rare. A grain of sand, an infectious parasite, or other irritant would pierce the mantle tissue of a wild oyster. The epithelial cells of the oyster would then secrete calcium carbonate ("nacre") over the irritant, making a pearl. Pearls were harvested from the warm tropical seas of the Persian Gulf around Arabia by divers sunk to the bottom with stones and were exported from a center in Bahrain throughout the world (Ward, 1985). A white, perfectly round pearl from Arabia was the most expensive gem of the ancient world (Taburiaux, 1986).

Pearls remain one of the most unusual and profitable fisheries in the world today. There are many types of pearls, large and small, round and tear drop-shaped ("baroque"), and colored, white to black. Perfectly round white and black pearls are the most in demand and command the highest prices.

In 1919, Kokichi Mikimoto discovered a way to induce a marine oyster to form a perfectly round pearl (Fassler, 1991). Mikimoto inserted a spherical bead of mussel shell called a "nucleus" together with a piece of calcium-secreting epithelial tissue from a donor oyster into the gonad of a Japanese *Akoya* oyster. These inserts induced the animal to deposit layers of calcium (nacre) over the nucleus, resulting in the world's first cultured pearl.

One of the most fascinating parts of this story is that the nucleus is a polished, round bead of shell taken from a member of the beautiful and diverse freshwater mussels that grow only in the southeast region of the United States (Lydeard et al., 1999). These large mussels of the family Unionidae, with interesting local names like the "washboards" and "pig toes," can weigh upwards of 4 kg and can provide beads as large as 15 mm in diameter. Many of these mussel species are endangered or threatened (Garner, 1999). Today, pearl aquaculture is centered in Australia, China, Japan, and the Pacific Islands and comprises a $10–$15 billion retail market (Table 1). The entire cultured pearl aquaculture industry in all of these exotic locales is dependent upon exports of unprocessed shells or beads (nuclei) made from the shells of freshwater mussels harvested from the southeastern United States (Haws and DiMichele, 1999).

On 25–26 March 1999, the Mississippi–Alabama Sea Grant Consortium (MASGC) sponsored a workshop at The University of Mississippi to organize a collaborative Sea Grant project that would examine the conservation biology, fisheries, aquaculture, and sustainable economic development of freshwater mussels and marine oysters. The MASGC is interested in developing pearl aquaculture in both freshwater and marine mollusks as new industries for the benefit of its stakeholders in the Gulf of Mexico. This special issue of *Gulf of Mexico Science* summarizes the major research, technical, economic, and marketing issues that were discussed and reviewed at the workshop.

Needs for Research to Develop a Gulf Pearls Industry

Workshop participants identified the top priority for research as the biotechnological aspects of molluscan biology, for both pearl mussels and oysters, especially the interrelationships of molluscan biology and grafting techniques, and genetic studies. Oysters are extremely sensitive to handling. Of 100 oysters implanted, only five will produce gem quality pearls, 15 will yield salable pearls, and 80 will produce nothing of value (Fassler, 1991). In addition, pearl growing is a long, 5–6-yr process. The shape and size of the bead and the numbers of layers of nacre determine value. Pearls from the wild are more valuable than cultured because they have less bead and more nacre.

Grafting biology was described as an ancient art, and taking that art and making it into a science is what is needed most. A pearl aquaculture biotechnology research program needs to be framed as a set of applied research questions, with the overall goal to explain the "art" of grafting biology in scientific terms so that

TABLE 1. Global centers of pearl aquaculture production in 1999.

Country	Estimated annual wholesale value ($)	Type of pearls produced
Japan	1 billion	Akoya oyster pearls (*Pinctada fucata*): small, white, perfectly round, marine pearls
China	750 million[a]	Freshwater pearls: white, colored and almost black, some almost perfectly round and indistinguishable from marine pearls, taken from various freshwater mussel species
Australia	200 million	Gold-lipped oyster pearls (*Pinctada maxima*): large, white, perfectly round, marine pearls
Tahiti	135 million	Black-lipped oyster pearls (*Pinctada margaritifera*): medium to large sized, black, marine pearls

[a] Estimates vary widely in the trade literature, but there is wide agreement that Chinese production is growing very rapidly and that the current total value of Chinese pearl production could be vastly underestimated.

progress can be made quickly. For example, a priority area was finding methods to relax the adductor mussels for staging proper implants. Such work could involve professionals from a medical school.

However, a successful implant has not so much to do with the nucleus but how you treat the epithelial graft tissue taken from the donor. In Japan, grafting technicians are highly skilled and can earn up to $150,000 per year. Technicians have a very precise way of locating the epithelial tissue they will use to implant with the bead. Dr. Koji Wada discovered that the pearl's color can be determined by the color of the mantle tissue implanted into an oyster (Federman, 1990). Grafting technicians have special tools to handle the tissue; they have a special board on which to put the tissue; they have a special knife to cut the tissue into strips. Little or no science is behind the current techniques. Why do you use this particular instrument? What are the biochemical and metabolic characteristics of the cells within that strip? We do not have any quantitative information about cell types from donors. Technicians just look; they judge; they cut it out; they implant. We need to examine the tissues that they consistently choose and discover the cell types and follow the correlation with color. Then determination can be made of which genes are being expressed. Those that have sequences that are homologous to color can be taken out, inserted in bacteria, and cloned.

The idea of automating grafting with robotics and computer imaging for implantation has merit, especially for choosing the proper placement and orientation for implantations. The Chinese have developed methods to insert multiple implants in each mollusk. Heterologous grafting with male tissues from foreign species as donors needs to be studied. Pearls have been cultured recently in abalone (Fankboner, 1991) and conch and could be grown in many other types of mollusks.

The idea of developing biocoated nuclei that would be more acceptable to the recipient oyster/mussel was discussed. Such nuclei would add further value to the Southeast's bead exports and could sell for prices three to four times over regular nuclei.

In freshwater pearl aquaculture, the priority research question is the performance of indigenous, riverine mussels in lentic (still-water) ponds, e.g. their survival, growth, and rates of nacre deposition and the influences of aquatic biology and water quality on these factors (Shaffer et al., 1999). Such research needs to be focused at a university biological field station in the Southeast.

In freshwater mussel shell fisheries, little or no information is available in the Southeast on the population dynamics of actively fished mussel populations exported for shells and beads. Bringing the power of fisheries population dynamics modeling to this capture fishery was identified as being a priority for both regulators and the shell harvest/exporting industry. Population dynamics assessments of mussels in their natural habitats could possibly be done by side-scan sonar or other remote techniques.

TECHNOLOGY TRANSFER NEEDS TO DEVELOP A GULF PEARLS INDUSTRY

Workshop participants felt strongly that an expanded pearl culture industry in the Southeast needs not to "recreate the wheel" but should draw upon national and international collaboration to share expertise and/or training. Collaboration might be costly in the sort term but in the long run may be less expensive. The best way to proceed in building an American pearl culture industry is to start

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building partnerships such as those formed at this workshop.

M. Haws is working on a video and manual on grafting (Haws and DiMichele, 1999). She used endoscopic cameras to monitor the grafts over time. Endoscopic cameras can also be used to monitor development of the pearl in situ.

Development of a broodstock and hatchery program in the Southeast in collaboration with Virginia Tech University would avail newcomers of their hatchery and nursery technologies (see Neves, 1999). Broodstock management, especially holding and developing valuable broodstock for selection, genetic, and biotechnology work could result in some valuable new processes, patents, and procedures.

Formation of the Pearl Association of the Americas

To initiate the project, the decision was made to form a university/industry collaborative research organization to support and promote the new industry technically and to provide extension support. The group formed the Pearl Association of the Americas and created a web page for it (http://www.masgc.org/pearl.htm). The group elected Dr. Lennie DiMichele, President; Dr. Barry Costa-Pierce, Vice-President; and Fay Pillars, Treasurer. The MASGC will maintain the web page for the group. An annual meeting was agreed upon, possibly in conjunction with the National Shellfisheries Association.

Conclusions

Sea Grant is committed to the concept that, to be of public benefit, research must be accessible to people. Sea Grant's advisory and educational programs provide access to current research results directly to communities, businesses, and industries. Sea Grant has played a critical role in the development of aquaculture in the United States. A short list of their successes includes pioneering technologies for striped bass pond culture with estimated value of $25 million per year, increasing the $86 million U.S. oyster market by over one-third, and developing mussel culture in the Northeast now valued at $6 million per year.

The MASGC intends to support the scientific, educational, and sustainable natural resource development goals of the newly formed Pearl Association of the Americas. The MASGC will help form university–industry partnerships to organize and promote new and innovative partnerships to develop pearl aquaculture in the Americas. On-going efforts by the MASGC to promote pearl aquaculture in the Southeast include negotiation with an industry partner to give American pearls a unique trademark and brand recognition by organizing a centralized research, marketing, and public relations effort similar to a model used in Tahiti. Tahiti has a levy of $1.60 per gram for every cultured pearl destined for export. Half of this levy goes to government taxes and the rest goes directly to the very successful *Perles de Tahiti* marketing organization. In 1998, *Perles de Tahiti* obtained $4.85 million in levies. In a similar manner, the MASGC would receive such funds generated by industry levies and use them to support research, marketing, promotion, and educational activities to develop pearl aquaculture in the Americas.

The final result may be that we are never able to culture pearls in oysters/mussels in any economically viable way in the Gulf of Mexico states. However, we may develop some new equipment, biotechnologies, or enucleation processes that could be as valuable as the pearls themselves. The southeastern United States is the only supplier of "raw," unprocessed shells from freshwater mussels in the world. Exports of raw shells and bead nuclei made from mussels form the backbone, the core, of the entire global pearl aquaculture industry. We need to, from the outset of our project, plan for ways to enhance the "value-added" aspects of our raw shell and processed bead exports and plan for all of the economic multiplier effects a new pearl industry can provide. Workshop participants felt strongly that a new "window of opportunity" exists and that the future of pearl aquaculture in the Gulf of Mexico and the Americas is bright. Pearl aquaculture in Japan has collapsed—over 90% of the oyster stocks are dead because of viruses and pollution—and there is much competition between Japan, China, and Australia for expansion into Indonesia and Micronesia. Black pearls from Tahiti are in short supply. We need to work together to develop a step-by-step plan to develop an indigenous pearl aquaculture industry in the Americas as a new means of sustainable economic development for coastal residents.

Literature Cited

Fankboner, P. 1991. Pearl culture in abalone. INFOFISH Int. 4/1991.

Fassler, R. 1991. Farming jewels: the aquaculture of

pearls. Aquacult. Mag. 17:34–52.

FEDERMAN, D. 1990. Biotechnology: a new dawn for pearl farming. Modern Jeweler, Sept. 1990, p. 1–7.

GARNER, J. 1999. Needs for research in biological conservation of freshwater mussels in the southeastern United States: an annotated outline. Gulf Mex. Sci. 17(2):123–125.

HAWS, M. C., AND L. DIMICHELE. 1999. New opportunities for economic benefits for the American southeast in the international pearl industry. Gulf Mex. Sci. 17(2):109–122.

LYDEARD, C., J. T. GARNER, P. HARTFIELD, AND J. D. WILLIAMS. 1999. Freshwater mussels in the Gulf region: Alabama. Gulf Mex. Sci. 17(2):123–134.

NEVES, R. J. 1999. Biological feasibility of freshwater mussel and pearl culture in Gulf Coast states. Gulf Mex. Sci. 17(2):103–108.

SHAFFER, L. R., A. C. MILLER, AND B. S. PAYNE. 1999. Preliminary results on studies of mussel shell gape under differing environmental conditions. Gulf Mex. Sci. 17(2):135–136.

TABURIAUX, J. 1986. Pearls: their origin, treatment and identification. Chilton Book Co., Radnor, PA.

WARD, F. 1985. The pearl. Natl. Geogr. Mag. 168: 193–222.

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